2511

Instruction Manual

Vibration Meter Type 2511

A fully-portable, battery-operated meter for acceleration, velocity, or displacement measurements in the frequency range 0,3 Hz to 15 kHz. The meter is directly calibrated in inch or metric units, RMS or Peak-to-Peak, with RMS or averaging time of 1 s or 10 s. A circuit which holds the maximum of a transient signal can also be selected. The frequency range of measurements can be limited by means of high-pass and low-pass filters. A piezoelectric transducer of sensitivity 10 pC/ms^{-2} is provided.

GE Rental/Lease

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VIBRATION METER
TYPE 2511

Applicable from Instruments from Serial No. 632034

Revision January 1981

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type 2511

Portable Vibration Meter

FEATURES:

- Self contained rechargeable battery supply
- Measures acceleration, velocity, and displacement parameters over a very wide range
- Frequency range 0,3 Hz to 15 kHz
- General purpose vibration pick-up supplied
- Calibrated in both British and Metric units
- RMS and true peak-to-peak detector with hold facility
- Selectable low-pass and high-pass filters
- External filter available
- AC; DC Lin; and DC Log, recorder outputs
- Built-in calibrator
- Battery charger supplied as standard

USES:

- Measurement and monitoring of vibration levels on machinery
- Production quality control
- Vibration severity measurements
- Vibration measurements on land, air, and sea vehicles
- Frequency analysis in conjunction with an external filter
- Failure forecasting and trouble shooting in industrial plant
- Measurements on vibration test set-ups

Vibration Meter Type 2511 is an exceptionally wide range instrument which is used in conjunction with a piezo-electric vibration pick-up to measure mechanical vibration and shock in terms of acceleration, velocity, and displacement. It is completely portable and is built to a high standard of accuracy and stability making it suitable for both laboratory and field conditions. The instrument is fully calibrated in both Metric and British units and has a charge amplifier input which allows the use of long cables between the pick-up and the meter without any reduction in sensitivity.

The 2511 is a valuable tool in the investigation of the dynamic behaviour of mechanical structures. It can be used to monitor vibration levels in production machines on a periodic basis so that any increases can be noted and corrective action taken before a complete machine failure. It may be used in production quality control to ensure that manufactured goods are within specification before dispatch. It can be used in tracking down the source of vibrations which produce noise so that damping can be applied. In design and development, it will be used in assessing the vibration "quality" of a prototype. In civil engineering it will be used in the investigation of vibration on roads, bridges, dams, buildings etc. In passenger transportation it will be used to assess the potential annoyance of vibration in ships, trains, cars, buses, aircraft etc. Its operation is simple and quite suitable for use by non-scientific personnel not conversant with electronic instrumentation.

Vibration Pick-up

Supplied as standard equipment with the 2511 is a Brüel & Kjær accelerometer Type 4370. This is a high quality piezo-electric device which produces an electrical signal proportional to the acceleration to which it is subjected and has an output of 10 pC/ms^{-2} (100 pC/g). This accelerometer will cover the majority of ordinary measuring needs but by using Accelerometers type 4371 or Type 8306 which have sensitivites of 0,1 x and 100 x relative to the Type 4370 the working range of the instrument is considerably increased. Fig.1 shows the measuring ranges of the 2511 with the three different accelerometers.

Dynamic Range

The measuring ranges shown in the table are for wide band measurements without any external filter. The lowest measurable levels are dependent on the internal noise level of the instrument, which is reduced as the measuring bandwidth is reduced. With the use of third octave or narrower bandwidth external filters, measurements can be made at significantly lower levels. The lower limits shown in Fig.1 are 6 dB above the wide-band RMS noise floor.

Integrators

In order to measure velocity or displacement parameters, the acceleration signal from the transducer is integrated or double integrated respectively.

Frequency Range and Filters

The instrument has a frequency range from 0,3 Hz to 15 kHz in the acceleration mode, in the velocity and displacement modes the frequency range will be determined by the integrator filters. The frequency characteristic in the three modes is shown in Fig.2.

Accelerometer	Mode. LLF for min. level		Wide Band Measuring Range Min.(RMS)	Max.
8306 10000 pC/g (~ 1000 pC/ms^{-2})	Acc'n 0,3 Hz	m/s^2	0,0001	1
		g	0,00001	0,1
	Vel. 3 Hz$^+$	mm/s	0,001	10
		in/s	0,00005	1
	Disp. 10 Hz$^+$	mm	0,0001	0,1
		inch	0,00001	0,01
4370 (10 pC/ms^{-2}) Supplied as std.	Acc'n 0,3 Hz	m/s^2	0,002	100
		g	0,0002	10
	Vel. 3 Hz$^+$	mm/s	0,02	1000
		in/s	0,001	100
	Disp. 10 Hz$^+$	mm	0,0003	10
		inch	0,00002	1
4371 (1 pC/ms^{-2})	Acc'n 0,3 Hz	m/s^2	0,02	1000
		g	0,002	100
	Vel. 3 Hz$^+$	mm/s	0,2	10000
		in/s	0,01	1000
	Disp. 10 Hz$^+$	mm	0,003	100
		inch	0,0002	10

Fig.1. Measuring ranges of the 2511 in conjunction with three B & K accelerometers. The figures quoted are for wide band measurements. The minimum RMS levels quoted lie 6 dB (2 x) above the wide band RMS noise level. For peak-to-peak measurements the wide band noise levels are approximately 17 dB (7 x) higher which will further limit the lower dynamic limit

+ By switching to the next lower LLF than stated in Vel. and Disp., the internal noise level (and therefore the lowest measurable level) will increase with a factor of 3 to 4.

A two position switch on the rear panel enables either a 1 kHz or 15 kHz low pass filter to be selected, which heavily attenuate the possible affect of high frequency vibration components on the accelerometer mounted resonance frequency. For measurements at frequencies above 1 kHz with Accelerometer Type 4370 which has a useful operating frequency range extending up to 6 kHz, extra attenuation of high frequency vibration components is needed. This can be achieved by mounting the Accelerometer on a Mechanical Filter UA 0559 before attaching it to the measurement point. Five UA 0559's are supplied in the Mechanical Filter Set UA 0553 which is available as an extra. With Accelerometers Type 8306 and 4371 which have a useful operating frequency range extending up to 1 kHz and 12 kHz respectively, the use of a mechanical filter is not necessary.

High pass filters are incorporated to limit the low frequency response of the instrument to 1 Hz, 3 Hz or 10 Hz as desired. This facility will reject the influence of low frequency noise and will be found particularly useful when measuring low level signals in the velocity and displacement modes.

With the instrument switched to measure RMS Velocity, with a lower limiting frequency of 10 Hz, and the 1 kHz Low Pass filter switched in, the pass band of the 2511 closely approximates the requirements of the VDI, ISO, BS, and DIN standards for vibration severity measurements.

External Filter

Input and Output sockets of the BNC Type are provided on the rear panel for direct connection of an external filter. The use of an external filter will increase the versatility of the instrument in that it can be made sequentially sensitive to a series of narrow frequency bands. This is necessary where it is required to perform a frequency analysis of a signal or locate the frequency at which a mechanical resonance peak occurs, for example. The portable,

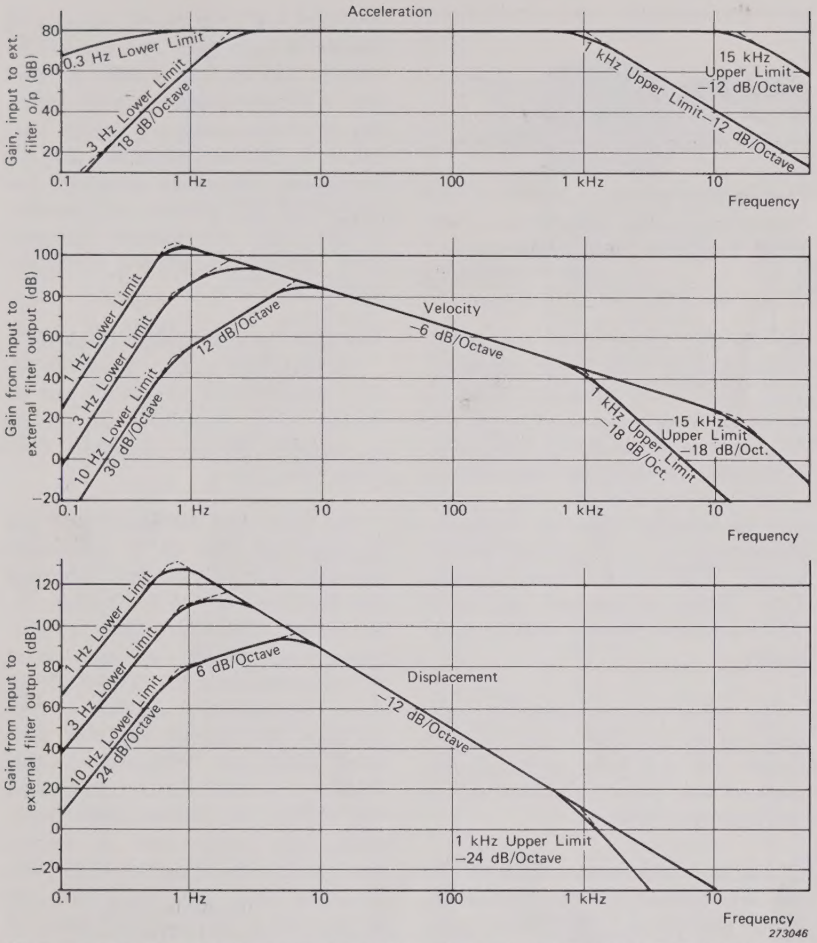


Fig.2. Transfer characteristic curves of the 2511 when switched to Acceleration. Velocity, and Displacement; the instrument is switched to maximum sensitivity. The dotted line shows the idealised filter shape

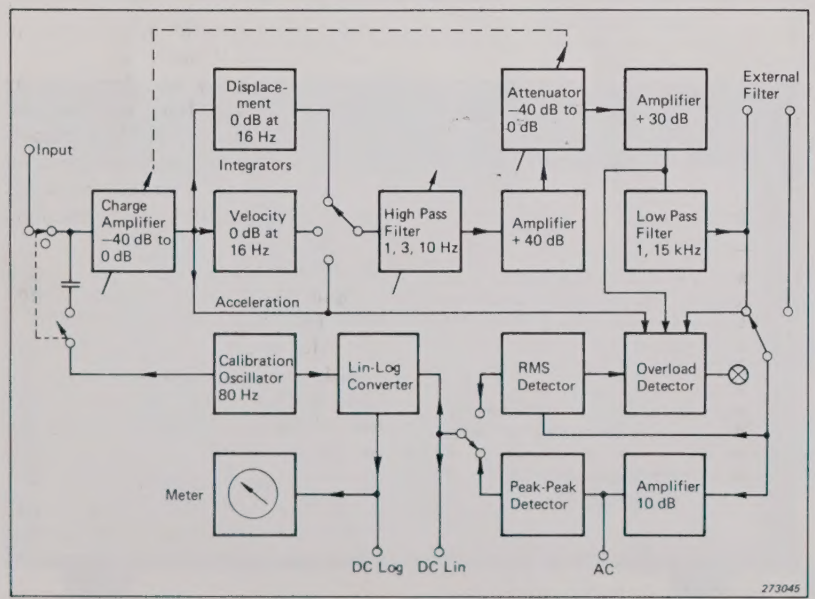


Fig.3. Block diagram of Vibration Meter Type 2511

battery operated, Tunable Band Pass Filter Type 1621 is ideal for use with the 2511. Either 23% (1/3 Octave) or 3% bandwidths are switch selectable and manually tunable over the frequency range 0,2 Hz to 20 kHz. Tracking Filter Type 1623 (see Fig.7) gives a choice of three bandwidths, 6%, 12%, and 23%, and can also be manually tuned. The 1623 can, additionally, be tuned from an external signal, for example from a photoelectric transducer, so that vibration level can be plotted as a function of a machine's varying rotation speed and its harmonics.

Meter, Detector, and Hold Facility

The indicating meter has a 40 dB measuring range (2 decades), and is logarithmically graduated from 1 to 100 giving the same reading accuracy throughout the range. A spare scale is supplied which is graduated directly in dB.

Both true peak-to-peak and RMS detectors are included in the 2511, these will be used according to the type of signal, and by requirements set by particular standards. Generally the RMS detector is used where the energy content of a signal is important, as for example, set by the vibration severity standards previously mentioned. The peak-to-peak detector is useful for measuring shocks, and vibration in the displacement mode.

A very useful feature is the "hold" facility which operates in both the RMS and peak-to-peak modes. This enables the meter to retain the maximum vibration level of a particular transient, for example an engine passing through a resonance. The maximum level is held on the meter after the peak has occurred.

Overload Indicator

To warn the user of an overload condition a warning light on the front panel is activated by a level detector. This detector senses overload at four different points in the circuit thus ensuring that all possible overload eventualities are covered.

Calibrator

The calibrator consists of an 80 Hz oscillator which applies a reference charge signal to the input of the instrument. This enables the meter to

be set to a reference point by means of the adjuster on the front panel. Calibration checks can be made on all three parameters, Acceleration, Velocity, and Displacement.

The meter calibration of the 2511 can be adjusted to suit accelerometer sensitivities between 0,7 and 1,3 times, or decade multiples of, the 4370's sensitivity by means of the calibrator adjuster. The meter pointer is moved from the 10 position on the secondary meter scale to read the actual charge sensitivity of the accelerometer used.

Input and Output

A standard miniature socket is provided on the front panel for direct input of the reinforced accelerometer cable. A parallel input socket on the rear panel accepts a BNC Type plug.

The acceleration, velocity or displacement signal as registered on the meter is also available from a BNC output socket on the rear panel of the instrument. The signal can thus be examined on an oscilloscope or a permanent record can be made by connecting a tape recorder or a chart recorder.

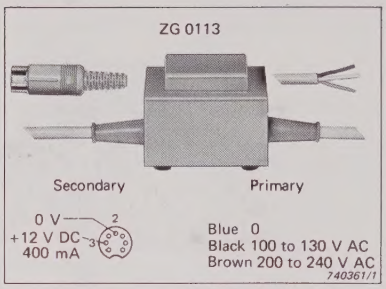
The signal is available as an unrectified AC output for oscilloscopes and many chart recorders. Some recorders require a DC signal, both linear and logarithmic proportional outputs are available for this case.

Power Supply

Supplied as standard with the 2511 are four rechargeable cells, QB 0008, and a battery charger unit, ZG 0113. For use in the field, the rechargeable batteries will give about 10 hours continuous operation. Where recharging from an AC mains supply is not possible the 2511 can be run from ordinary IEC Type 20 cells. Good quality alkaline cells can give about 15 hours continuous operation, and ordinary "long life" cells give up to 4 hours continuous operation.

In the laboratory and for more permanent applications the charger unit permanently coupled to the fully charged cells will be the most convenient form of power supply.

Where it is required to operate the instrument and recharge the batteries at the same time, the B & K Power Supply Type 2808 should be used. A 12 V car battery can also be used to simultaneously charge the NiCd cells and power the 2511. For permanent monitoring applications where a number of vibration meters may be installed together, it will be convenient to use a common power supply. The B & K Power Supply Type 2805 can power up to 8 2511's simultaneously with a ± 14 V supply.



The meter scale is marked to indicate battery condition; when a push button on the front panel is depressed the meter indicates battery recharging or renewal.

Low g accelerometer Type 8306 has an impedance converter built-in which requires a + 28 V power supply, this can be taken from a miniature connector on the front panel.

Physical

The 2511 is a light-weight easily operated instrument with a large 110 mm x 63 mm meter. A carrying handle is built into the top of the cabinet and the underside is fitted with a hinged support leg for inclining the instrument for bench use. With the "B" version of the 2511 a mahogany cabinet is supplied. The removable lid contains the accelerometer and accessories conveniently stored for on-site measurements.

The 2511 as a Vibration Analyzer

As described under "External Filter", the 2511's versatility can be considerably increased by adding a portable, battery operated, band pass filter.

The 2511 and the filter 1621 are supplied together as a completely portable vibration analyzer set Type 3513, shown in Fig.6. The two instruments are fitted into a lightweight but robust hard-foam plastic carrying case KA 2000. Other items included in addition to the standard accessories normally supplied with the individual instruments are two connection cables AO 0133, six rechargeable NiCd-cells QB 0008 and a battery charger ZG 0113 for the 1621. The Tracking Filter Type 1623 can also be housed in the carrying case KA 2000 together with a Vibration Meter Type 2511. Please ask for the separate product data sheets covering the Filters Types 1621 and 1623.

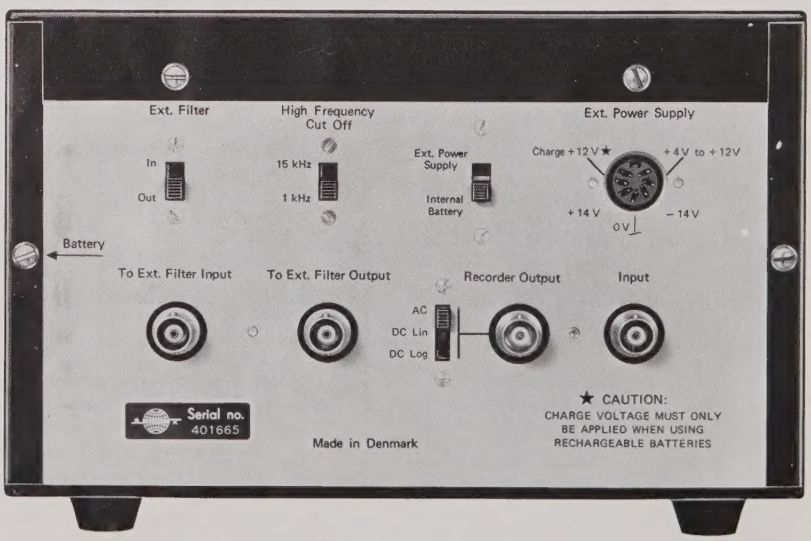


Fig.4. Rear view of the Vibration Meter Type 2511

Specifications 2511

Sensitivity:

Mode	With Accelerometer 4370, 10 pC/ms^{-2}		With Accelerometer 4371, 1 pC/ms^{-2}	
	Sensitivity (Full Scale)	Freq. Range	Sensitivity (Full Scale)	Freq. Range
Acceleration	0,01 to 100 m/s^2	0,3 Hz to 1 kHz (6 kHz)*	0,1 to 1000 m/s^2	0,3 Hz to 15 kHz
	0,001 to 10 g		0,01 to 100 g	
Velocity	0,1 mm/s	3 Hz + to 1 kHz (6 kHz)*	1 mm/s	3 Hz+ to 15 kHz
	0,01 in/s		0,1 in/s	
	1 mm/s	1 Hz to 1 kHz (6 kHz)*	10 mm/s	1 Hz to 15 kHz
	0,1 in/s		1 in/s	
	10; 100; 1000 mm/s	1 Hz to 1 kHz (6 kHz)*	100; 1000; 10000 mm/s	1 Hz to 4 kHz
	1,0; 10; 100 in/s		10; 100; 1000 in/s	
Displacement	0,001 mm	10 Hz + to 1 kHz (2,5 kHz)*	0,01 mm	10 Hz+ to 2,5 kHz
	0,0001 in		0,001 in	
	0,01 mm	3,16 Hz + to 850 Hz	0,1 mm	3,16 Hz+ to 850 Hz
	0,001 in		0,01 in	
	0,1; 1,0; 10 mm	1 Hz to 275 Hz	1; 10; 100 mm	1 Hz to 275 Hz
	0,01; 0,1; 1,0 in		0,1; 1,0; 10 in	

Vibration Pick-up:
B & K Piezoelectric Accelerometer Type 4370
Sensitivity: 10 pC/ms^{-2} (~ 100 pC/g)

Max. Equivalent Noise Level:
With a 10 pC/ms^{-2} accelerometer and switched to RMS detector:
Acc.: 0,001 m/s^2 (~ 0,0001 g) 0,3 Hz to 15 kHz
Vel.: 0,01 mm/s (~ 0,0004 in/s) 10 Hz to 15 kHz
Disp.: 0,00015/ mm (0,000006 in) 10 Hz to 1 kHz

Accuracy (incl. accelerometer):
± 5% absolute overall for 2511 + accelerometer within linear ranges. At both ends of a selected frequency range the accuracy is ± 5% from the appropriate filter characteristic (see also Fig.2)

High-Pass Filter:
3 Pole Butterworth, fall off 18 dB/octave

Low-Pass Filter:
2 Pole Butterworth, fall off 12 dB/octave

Detectors:
Quasi RMS:
True reading indicated for sinusoidal signals and noise with crest factor < 3
Time Constants 1 s and 10 s switchable
Time Constant in "Max. Hold": 1 s
Max. Hold drift: < 10% per 5 min. with f.s.d. and < 40°C < 80% RH

True Peak-to-Peak:
Time Constants 1 s and 10 s
Max. Hold drift: < 10 % per 30 min. with f.s.d. and < 40°C < 80% RH
Rise time: > 25μs (15 kHz LP filter)
Dynamic Range for both detectors: 40 dB

External Filter Sockets:
2 x BNC
Signal level 1 V peak or RMS
Input socket impedance: 16 kΩ

Recorder Outputs:
Output Impedance: 1 kΩ
Approx. levels for f.s.d.
AC: 2,7 V RMS. Overload 6,8 V peak
DC log: 2,0 V; 0,05 V/dB. Overload 2,25 V
DC Lin: 3,0 V. Overload 4,5 V

Meter Calibration:
Adjustable to suit accelerometer sensitivity
Range: ± 3 dB

External Power Supply:
+ 4 V to + 15 V, 1,7 W (2 W in Ref.) or ± 14 V, 45 mA

Internal Power Supply:
4 x 1,5 V cells (IEC Type R 20)

Battery Life:
9 to 10 hours continuous operation with NiCd cells 15 hours with Alkaline and 3 to 4 hours with standard batteries
Charging time for fully discharged batteries: approx. 14 hours. Charging current: approx. 400 mA

Environmental Conditions:
Operating temperature:—10°C to + 50°C
Humidity range: 0 to 95% relative humidity non condensing
Electromagnetic fields up to 100 amp/m increase noise floor < 14 dB

Cabinet:
A model. B & K module cabinet KK 0025, 6/12 of 19" rack module
B model, as A model but with mahogany cabinet and shoulder strap

Dimensions: (excl. feet, knobs, etc.)
Height: 133 mm (5,2 in)
Width: 210 mm (8,3 in)
Depth: 200 mm (7,9 in)

Weight:
2,4 kg (5,3 lb)

Accessories Included:
Accelerometer Type 4370
Reinforced low noise, Teflon PFA cable — AO 0122 3 m (10 ft) long
Low noise, Teflon, cable AO 0038 1,2 m (4 ft) long
Magnet UA 0070, Probe with sharp tip YP 0080, Round tip DB 0544, 2 Nipples for water cooling DB 0524
4 Rechargeable batteries QB 0008
Battery charger ZG 0113
dB scale SA 0208
7 pin DIN plug JP 0703
3 BNC plugs JP 0035

Accessories Available:
Wide range of accelerometers and filters
Mechanical filter set UA 0553
Mahogany Cabinet KA 0055
Power Supply Type 2808
Connection cable for 2808 AQ 0035

+ Low frequency limits determined by noise, lower frequencies possible with external filter
* With 1 kHz low-pass filter switched out and external filter used. (6 kHz is accelerometer + 10% limit)

Filter Attenuation:

Mode	0,3 Hz HP	1 Hz HP	3 Hz HP	10 Hz HP	1 kHz LP	15 kHz LP
Acceleration	< 30% at 0,3 Hz < 5% at 0,7 Hz	—	< 3% at 3 Hz < 5% at 2,9 Hz	—	< 30% at 1 kHz < 5% at 600 Hz	< 30% at 15 kHz < 5% at 9 kHz
Velocity	—	< 10% at 1 Hz < 5% at 1,2 Hz		< 3% at 10 Hz < 5% at 9,2 Hz		
Displacement	—	< 20% at 1 Hz < 5% at 1,3 Hz				

Data Recording

The results of vibration measurements and analyses made out in the field will usually need to be reviewed or analyzed at a later date. While the results can be noted by hand from the meter of the 2511, some form of permanent record made directly on-the-spot, will often be desirable for speed and convenience.

Direct paper chart recordings can be made by using the small, portable battery operated Level Recorder Type 2306, shown in Fig.8, together with the vibration meter. For frequency analysis work; (for example using the filter sets Types 1616, 1621, and 1623 with the 2511) the paper movement of the level recorder can be synchronised with the frequency sweep of the filter so that frequency and amplitude calibrated spectrograms can be produced directly. Suitable recording paper for graphic recording of frequency analyses with a 2306 and 2511 is QP 0120.

Where it is required to record vibration signals out in the field for later analysis in the laboratory, the Portable Instrumentation Tape Recorder Type 7003 shown in Fig.9 should be used. This is a battery operated, four channel FM recorder with specifications fully up to laboratory requirements. Sequential frequency analysis of transient and non-repetitive signals, such as mechanical shocks, is conveniently performed using the tape loop cassette supplied as standard.

Please ask for separate product data brochures covering the Portable Level Recorder Type 2306 and the Portable Tape Recorder Type 7003.

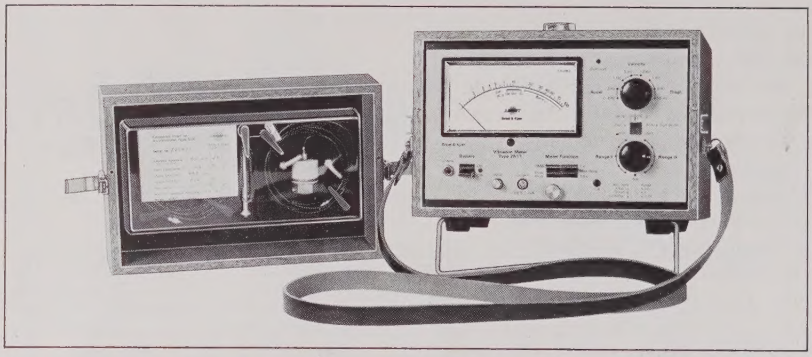


Fig.5. Type 2511 B consists of the Type 2511 A fitted into a mahogany cabinet with shoulder strap, and accessories stored in the lid

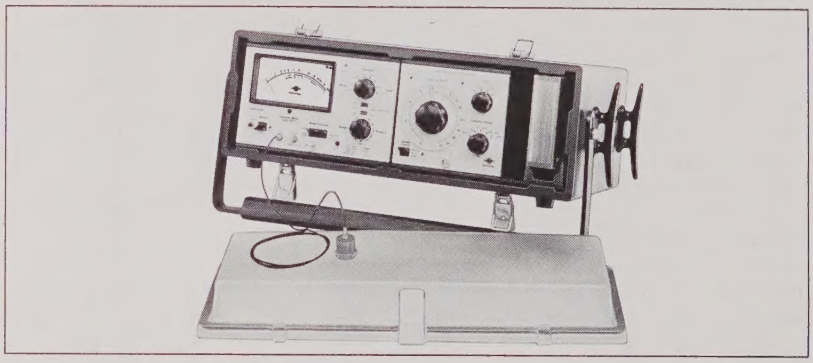


Fig.6. Portable Vibration Analyzer Type 3513 consists of the Vibration Meter Type 2511 combined with the Tunable Filter Type 1621, fitted into a rugged, lightweight case

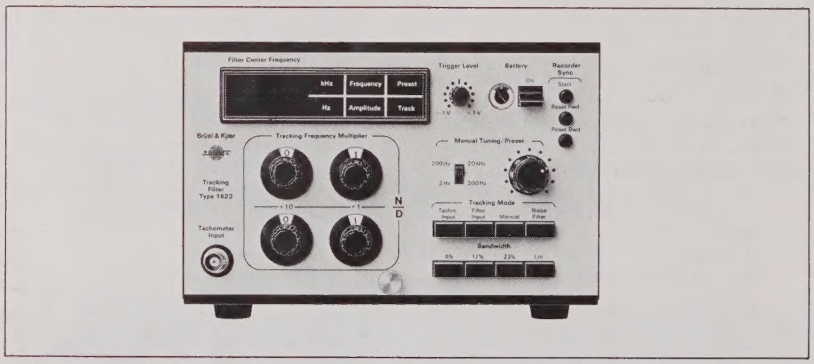


Fig.7. The Tracking Filter Type 1623

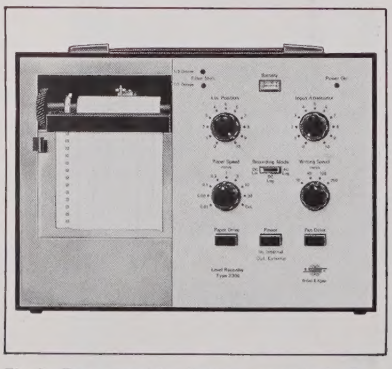


Fig.8. The portable, battery operated, Graphic Level Recorder Type 2306 (Also available in leather carrying case, Model F)

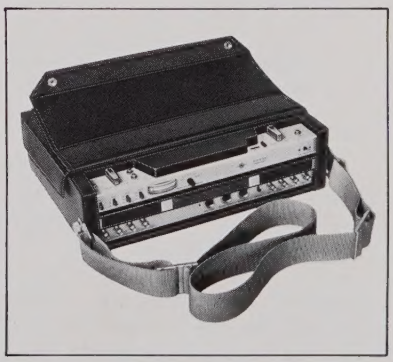


Fig.9. The portable, battery operated FM Tape Recorder Type 7003 (Model F in leather carrying case shown)

2. CONTROLS

2.1. FRONT PANEL

Fig.2.1. Front panel of the 2511

METER: Moving coil indicating meter, equipped with interchangeable scale SA 0183. For reading of measured vibration levels the upper range of the scale is used. This is graduated from 1 to 100% of full scale where 100% corresponds to the vibration level appearing in the window immediately above the RANGE SELECTOR switch. The two lower ranges are accelerometer charge sensitivity adjustment and battery check ranges. For special applications, a linearly graduated dB scale SA 0208 may be fitted. See section 3.7.

BATTERY: Power "On-Off" switch of instrument. Connects the internal batteries or an external +4 to +15 V DC supply selected with the INT.-EXT.

POWER switch on the rear panel. When powered the red lamp beside the switch should light.

Note: The BATTERY switch and power indicator lamp are not operative when an external ±14 V DC supply is used.

CHECK: Small push-button for meter check of internal battery status. If the meter pointer registers outside or only just inside the "Battery" check range of the scale, the internal batteries should be replaced or recharged. See section 3.2.2.

INPUT: Miniature coaxial input socket for connection of the output of B & K Uni-Gain® Accelerometers using the reinforced accelerometer cable AO 0122 supplied, or other low noise, miniature accelerometer cables which are available.

OUTPUT +28 V (2 mA): Miniature coaxial output socket supplying a +28 V (2 mA) DC for powering the B & K Uni-Gain® Accelerometer Type 8306 (accessory available) when the 2511 is powered using its internal battery supply or an external +4 to +12 V DC source.

METER FUNCTION: Two paddle switches for selection of the following meter functions:

"RMS." The meter displays the root mean square level of the measured vibration.

"Peak-Peak." The meter displays the peak to peak level of the measured vibration.

"1 s." Selects 1 s RMS averaging time and Peak to Peak decay time for measurement of reasonably steady vibration levels.

"Max. Hold." Meter holds maximum RMS or maximum peak to peak level of measured vibration. Enables mechanical shocks as short as 25 μs to be measured in the "Peak-Peak" mode.

"10 s." Selects 10 s RMS averaging time and Peak to Peak decay time for a reasonably steady meter indication with fluctuating vibration levels.

ACC.-VEL.-DISPL: Eight position switch for selection of vibration acceleration, velocity or displacement measurement modes, together with low frequency limit of measurement range.

RANGE SELECTOR: Eleven position switch for selection of measurement range. The ranges are:

"Range I." Five left-hand positions for selection of metric ranges in ms^{-2}, mms^{-1} or mm, depending on ACC.-VEL.-DISPL. switch setting.

"Range II." Five right-hand positions for selection of ranges in g, inch/s or inch, depending on ACC.-VEL.-DISPL. switch setting.

"Ref." Connects internal 80 Hz sawtooth reference signal for calibration of the instrument when the "RMS" (not "Peak-Peak") **METER FUNCTION** is selected. Should give pointer deflection on

"Cal.—pC/ms^{-2} " range of meter scale, corresponding with the specified charge sensitivity of the particular accelerometer employed. If not, adjust the "Cal." potentiometer until the exact sensitivity is indicated.

The value corresponding to full scale meter deflection with the particular range selected, appears in the FULL SCALE window just above the RANGE SELECTOR switch. The table just below the RANGE SELECTOR switch gives the multiplication factor to be used with 3 different accelerometer sensitivities.

CAL: Multiturn preset potentiometer for adjustment of meter to indicate exact sensitivity of the particular accelerometer employed, when the "Ref." mode of the RANGE SELECTOR switch selected.

OVERLOAD: A red indicating lamp which lights when the instrument is overloaded by vibration signals of too high a peak level. Responds to peak overloads as short as 50 μs and remains lit for approximately 0,5 s after overload is removed.

2.2. REAR PANEL

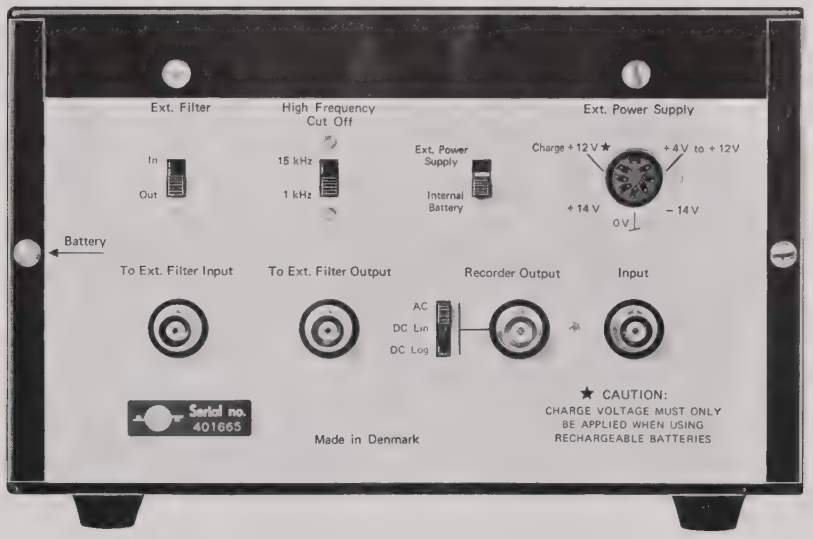


Fig.2.2. Rear panel of the 2511

EXT. FILTER: Two position switch, connects or by-passes external filter.

TO EXT FILTER INPUT—OUTPUT: Two BNC sockets for connection of an external filter such as the Tunable Filter Type 1621 or Tracking Filter Type 1623 to the instrument. The TO EXT. FILTER OUTPUT socket has an input impedance of 16 kΩ, while the TO EXT. FILTER INPUT socket should not be loaded by less than 100 kΩ. The input voltage which may be applied to the TO EXT. FILTER OUTPUT socket is 1 V for full scale meter deflection.

HIGH FREQUENCY CUT-OFF: To position switch for selecting "1 kHz" and "15 kHz" upper frequency limits of the measurement range. The high frequency attenuation slope is 40 dB / decade (12 dB/octave).

INT.-EXT. POWER:

Two position switch for selecting either "Internal Battery" or "Ext. Power Supply". See section 3.2.

EXT. POWER SUPPLY:

7 pin socket, accepting the DIN plug (B & K No. JP 0703) provided for powering the instrument, as well as recharging its internal battery supply from an external DC source. Before connecting a supply, see section 3.2.

RECORDER OUTPUT:

A BNC socket, plus three position switch for selection of a "DC Lin" or "DC Log" output for connection to a level recorder, or a "AC" Lin output for connection to a level or tape recorder. The approximate output voltage level corresponding to full scale deflection on the meter is + 3 V "DC Lin.", + 2 V "DC Log." and 2,7 V RMS "AC". Output impedance is 1 kΩ.

INPUT:

An alternative input connected in parallel with input socket on front panel. Accepts BNC coaxial plugs, as well as a BNC-Microdot socket adaptor JP 0145.

BATTERY:

A screw for releasing left hand side panel as viewed from rear) to obtain access to battery department. See section 3.2.

3. OPERATION

3.1. MOUNTING

The 2511 is designed to fit into the B & K Module System. It may be used free standing on its four plastic feet or, for better viewing, the front of the instrument may be raised using the integral metal stand shown in Fig.3.1. Alternatively with its four plastic feet removed, it may be mounted in a Mahogany Cabinet KA 0055 or Carrying Case KA 2000. These are shown in Figs.5 and 6 of Chapter 1 and are available as accessories. For further details, the B & K Short and Main Catalogues should be consulted.

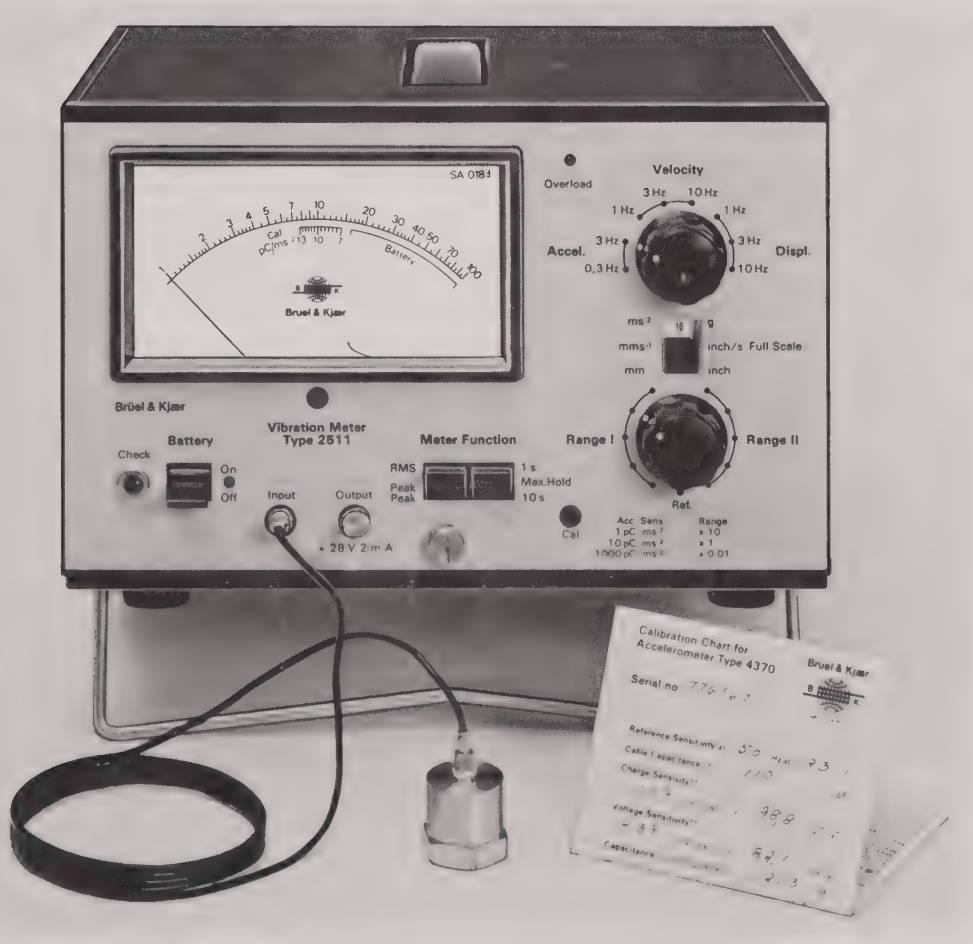


Fig.3.1. The 2511 with front raised using its integral metal stand

3.2. POWER SUPPLIES AND THEIR USE

3.2.1. Internal Battery Supply

The 2511 is supplied with four rechargeable nickel cadmium cells QB 0008. These are for use in the internal battery compartment of the instrument and have a voltage and charge rating of 1,2 V and 4 amp. hours respectively. They may be recharged a minimum of 500 times before needing to be replaced and with each charge provide approximately 9 to 10 hours of continuous operation with the 2511.

The 2511 may also be powered using four 1,5 V standard dry cells or long life alkaline dry cells - IEC Type R 20 (D cells). Depending on the particular brand used, standard dry cells provide between 3 and 4 hours of continuous operation, whilst long life alkaline types provide up to 15 hours. Unlike nickel cadmium cells QB 0008, they may not be recharged and therefore when fully discharged should be replaced.

To fit the 2511 with standard dry cells or rechargeable cells, proceed as follows:

1. Stand the 2511 on its left-side panel (as viewed from front of instrument) and slide off its right-side panel, after having removed the screw indicated by the "Battery" arrow on the rear panel.

2. Load four new or freshly charged cells, taking care that their positive poles (stud on cell casing) face the direction indicated in the battery compartment of the instrument.

   WARNING: Never fit cells with the poles reversed. Similarly never mix different makes or types of cell, or cells that have been used in other instruments. This can cause internal reversal of the cell polarity, making the instrument unsafe when rechargeable cells are recharged, as well as increasing the chance of battery leakage.

3. Replace the right side panel and label the instrument, stating which type of cells have been installed. If alkaline or standard dry cells have been fitted, then also include the warning "EXPLOSION RISK — NOT TO BE RECHARGED."

4. Set the INT.-EXT. SUPPLY switch on the rear panel to "Internal Battery", ready for operation.

3.2.2. Battery Check

To check the Charge status of the internal battery supply, set the INT.-EXT. SUPPLY switch to "Internal Battery". With the BATTERY switch set to "On" and the CHECK pushbutton pressed, the pointer of the indicating meter should deflect to the "Battery" range of the scale. If not, or the pointer registers only just within the "Battery" range, the internal batteries should be replaced or recharged.

Note: For an accurate battery check, disconnect all external DC supplies which may be connected.

3.2.3. Mains Battery Charger ZG 0113

For recharging nickel cadmium cells QB 0008, a Battery Charger ZG 0113 is supplied. This is shown in Fig.3.2 and is a double insulated mains operated supply which can provide up to 400 mA at 12 V DC. To protect the Charger against current overload, a self resetting thermal trip which operates at 80°C is built-in.

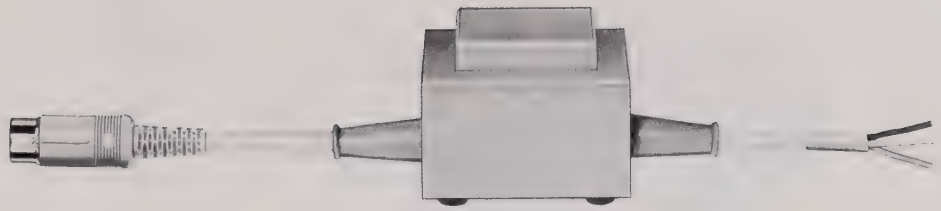


Fig.3.2. Battery Charger ZG 0113

For operation from different supply voltages, the mains cable of the Charger has the following colour coding:

Blue Neutral
Black 100 to 130 V (50 to 400 Hz) AC
Brown 200 to 240 V (50 to 400 Hz) AC

Before connecting the Charger to the mains, the particular Brown or Black mains lead not used should be clipped short and covered with insulating tape.

To commence charging, set the BATTERY switch of the 2511 to "Off" and connect the EXT. POWER SUPPLY socket on the rear panel with the 7 pin DIN plug of the Charger. The cells will start to recharge immediately the mains supply is connected. For totally discharged cells the recharge time is approximately 19 hours, however the cells may be left on charge for an indefinite period without danger of overcharging. At the end of the charge period, disconnect the Charger from the 2511 and carry out the Battery Check procedure described in section 3.2.2. If the cells fail to give a suitable battery check indication then they should be replaced.

Note: The Battery Charger ZG 0113 cannot be used for recharging nickel cadmium cells whilst the 2511 is being used for measurements. However, provided the cells are not completely discharged, then it may be used to power the 2511 whilst preventing further discharge from the cells. For this purpose ZG 0113 should be connected to the EXT. POWER SUPPLY socket of the 2511 and the INT.-EXT. SUPPLY and BATTERY switches of the instrument should be set to "Internal Battery" and "On" respectively.

3.2.4. Mains Power Supply and Battery Charger Type 2808

For operation from a 100 to 240 V AC mains supply, the 2511 may be used with the Power Supply Type 2808 shown in Fig.3.3. This is available as an accessory and has separate output lines for powering the 2511 whilst at the same time recharging the nickel cadmium cells contained in its battery compartment. The power output line provides up to 1,25 A at 7,5 V DC, whilst the charge output line provides up to 400 mA at 12 V DC. When first using the 2808 it is important that the mains voltage setting and fuse checks given in its Instruction Manual are carried out to ensure safe operation with the 2511.

For powering the 2511, set its INT.-EXT. POWER switch to "Ext. Power Supply" and connect its EXT. POWER SUPPLY socket to the OUTPUT socket of the 2808 using a standard 7 pin DIN cable (pin 1 to 1, pin 2 to 2, etc.) AQ 0035. If the 2511 contains alkaline or standard dry cells, then ensure the CHARGE switch on the 2808 is set to "Off" before connecting the mains supply.

To recharge nickel cadmium cells in the 2511, connect the 2808 as above and set its CHARGE switch to "On". There is no need to set the BATTERY switch of the 2511 to

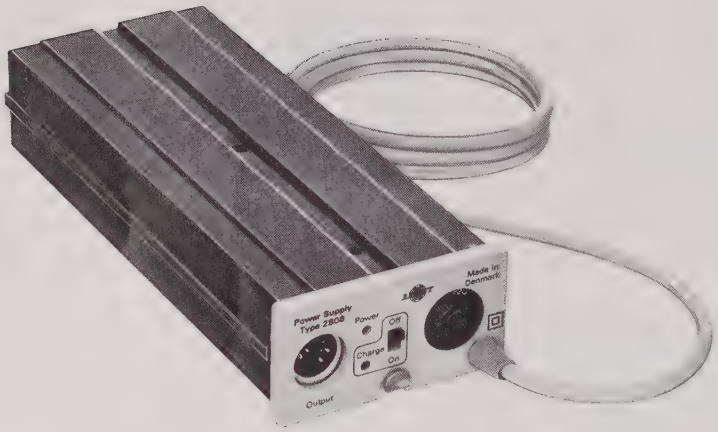


Fig.3.3. Power Supply Type 2808

"On", unless it is also required to power the instrument at the same time. For totally discharged cells the recharge time is approximately 19 hours. There is no danger of overcharging by leaving the cells on charge for a longer period.

For further information on the 2808 Power Supply, its Instruction Manual should be consulted.

3.2.5. Ext. Battery or other DC Source

For connection of an external battery or other external DC source, the EXT. POWER socket of the 2511 has the pin identities shown in Fig.3.4. When using this socket the INT.-EXT POWER switch of the 2511 should be set to "Ext. Power Supply". Both single and dual polarity DC power inputs are provided, as well as a charge input. The +4 to +12 V DC single polarity input can tolerate up to +15 V DC without damage to the instrument. Do not connect a +12 V charge source, if alkaline or standard dry cells are fitted. With nickel cadmium cells QB 0008, the recharge time is approximately 19 hours. There is no danger of overcharging by leaving the cells on charge for a longer period.

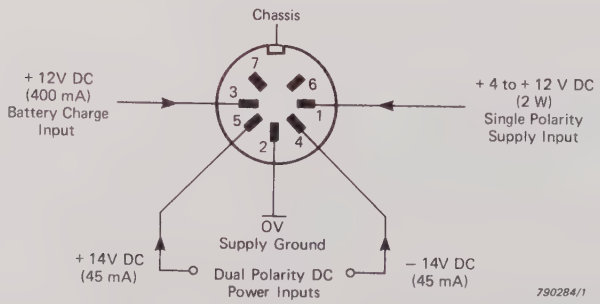


Fig.3.4. External view of the EXT. POWER socket of the 2511

For simultaneous operation and recharging using a single external DC source, the EXT. POWER SUPPLY socket may be connected with a 12 V car battery, as shown in Fig.3.5. If a car's own 12 V battery is used for this purpose, then the ignition system may be left running whilst recharging is carried out, but not when operating the 2511. Also care

should be taken to ensure that the cabinet of 2511 and of other instruments with which it is used are not touching the metal bodywork of the car. This is particularly important with cars having a positive earth system, as when the battery is connected the chassis of the instruments will be at a potential 12 V lower than that of the car chassis and could short circuit the battery if allowed to touch the car bodywork. Aside from damaging the 2511, such a short can severely burn the user.

Note: When using an external battery or mains powered DC supply other than Type 2808 or ZG 0113, the live DC line of the supply should be connected to the EXT. POWER socket of the 2511 via a suitable "fast-blow" protection fuse such as that indicated in Fig.3.5.

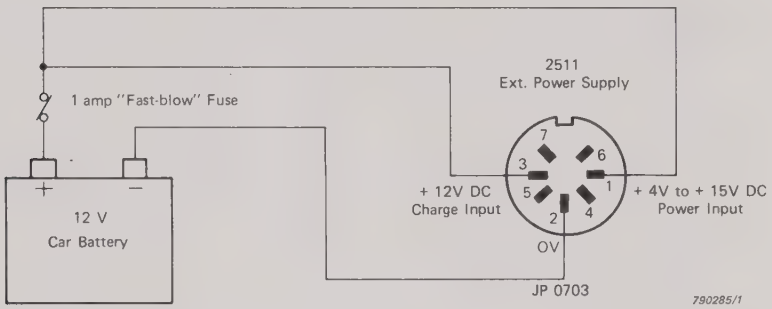


Fig.3.5. Connection of 12 V car battery for simultaneous operation and recharging with the 2511

3.3. CALIBRATION WITH UNI-GAIN® ACCELEROMETER TYPE 4370

Before the 2511 can be used for measurements it should be calibrated for the precise sensitivity of the particular accelerometer employed. This may be done using the internal reference voltage of the 2511 or using the Accelerometer Calibrator Type 4291 which produces an acceleration reference level of 10 ms^{-2} peak. As calibration using the 4291 also includes the accelerometer, it is particularly valuable in checking whether the accelerometer has been damaged by maltreatment.

3.3.1. Using Internal Reference

To calibrate the 2511 using its internal reference voltage proceed as follows:

1. On the rear panel of the 2511 set:

EXT. FILTER	"Out"
HIGH FREQ. CUT OFF	"15 kHz"
INT-EXT POWER	"Internal Battery"

2. On the front panel set:

METER FUNCTION	"RMS" — "1 s"
ACC.-VEL.-DISPL.	"Acc." "3 Hz"
RANGE 1 - II	Extreme clockwise setting
BATTERY	"On"

3. Press the CHECK push-button and check that the pointer of the indicating meter deflects to the "Battery" region of its scale. If not, replace or recharge the internal batteries. See section 3.2.

4. From the calibration chart supplied with the Accelerometer to be used for measurements read off its exact charge sensitivity in pC/ms^{-2}.

5. Set the RANGE I-II knob to "Ref." and using the small screwdriver provided, adjust the CAL. potentiometer of the 2511 to produce a pointer deflection on the "Cal.-pC/ms^{-2}" scale of the meter, corresponding with the exact charge sensitivity of the accelerometer.

6. Using the ACC.-VEL.-DISPL. knob, select the "Acc.–3 Hz", "Vel.–10 Hz" and "Displ.–10 Hz" settings in turn and wait to obtain a stable meter indication with each setting. Provided that the 2511 is functioning correctly, the same meter indication (to within ± 5%) should be obtained as in item 5.

   Note: For an accurate function check with the "Vel.–1 Hz", "Displ.–3 Hz" and "Displ.–1 Hz" settings, an external narrow band filter should be connected. The centre frequency of the filter should be adjusted to approximately 80 Hz so as to obtain maximum meter indication with the internal reference of the 2511.

7. Having calibrated and checked the correct function of the 2511, turn the RANGE I-II knob to its extreme clockwise position, ready for measurements.

3.3.2. Using the Accelerometer Calibrator Type 4291

To calibrate the 2511 using the Accelerometer Calibrator Type 4291, proceed as follows:

1. On rear panel of the 2511, set:

EXT. FILTER	"Out"
HIGH FREQ. CUT OFF	"15 kHz"
INT.-EXT. POWER	"Int. Battery"

2. On front panel, set:

METER FUNCTION	"RMS - 1 s"
ACC-VEL-DISPL	"Acc - 3 Hz"
RANGE I-II	Extreme clockwise position
BATTERY	"On"

3. Press the CHECK push-button and check that the pointer of the indicating meter deflects to the "Battery" region of its scale. If not, replace or recharge the internal batteries. See section 3.2.

4. Mount the accelerometer to be used for measurements on the vibration table of the 4291, using a 10 - 32 NF screw stud, or other approved mounting technique.

5. Connect the Accelerometer output to one of the INPUT sockets of the 2511, using one of the low noise accelerometer cables supplied.

6. Set the FUNCTION SELECTOR of the 4291 to "Batt. Check". The pointer of its indicating meter should deflect to the "Battery" region of its scale. If not, the internal batteries of the 4291 should be replaced.

7. Set the FUNCTION SELECTOR of the 4291 to "Internal Gen." and turn the ACC. LEVEL knob until the meter indicates the mass of the accelerometer on the 0 to 100 grms range of its scale. The 4291 is now adjusted to vibrate the accelerometer at 10 ms^{-2} peak (i.e. 7,07 ms^{-2} RMS or 20 ms^{-2} peak to peak).

   Note: The mass of the accelerometer is specified on its calibration chart.

8. Using the small screwdriver provided, adjust the CAL. potentiometer of the 2511 for a meter indication of 7,07 ms^{-2} RMS. With the METER FUNCTION set to "Peak-Peak" a meter indication of 20 ms^{-2} Peak-Peak should be obtained.

9. To check the correct function of the integrators of the 2511, set the ACC.-VEL.-DISPL. knob to "Vel.-10 Hz" and turn the RANGE I-II knob one position anticlockwise so that 100 mm/s is displayed in the FULL SCALE window between the knobs. The meter should indicate 14,1 mms^{-1} RMS or 40 mms^{-1} Peak to Peak.

   Similarly, set the ACC.-VEL.DISPL. knob to "Displ.-10 Hz" and turn the RANGE I-II knob one position anticlockwise so that "0,1 mm" is displayed in the FULL SCALE window. The meter should indicate 0,0283 mm RMS or 0,08 mm Peak-Peak.

10. Having calibrated and checked the correct function of the 2511, disconnect the 4291 and turn the RANGE I-II knob to its extreme clockwise position, ready for measurements.

3.4. MEASUREMENTS WITH UNI-GAIN® ACCELEROMETER TYPE 4370

1. Calibrate the 2511 as described in section 3.3.1 or 3.3.2.

2. Fasten the accelerometer to the measurement object. Accelerometer Type 4370 is best fastened using the Mechanical Filter UA 0559 which is available as an accessory. This may be attached to the measurement object as indicated in Fig.3.6 and

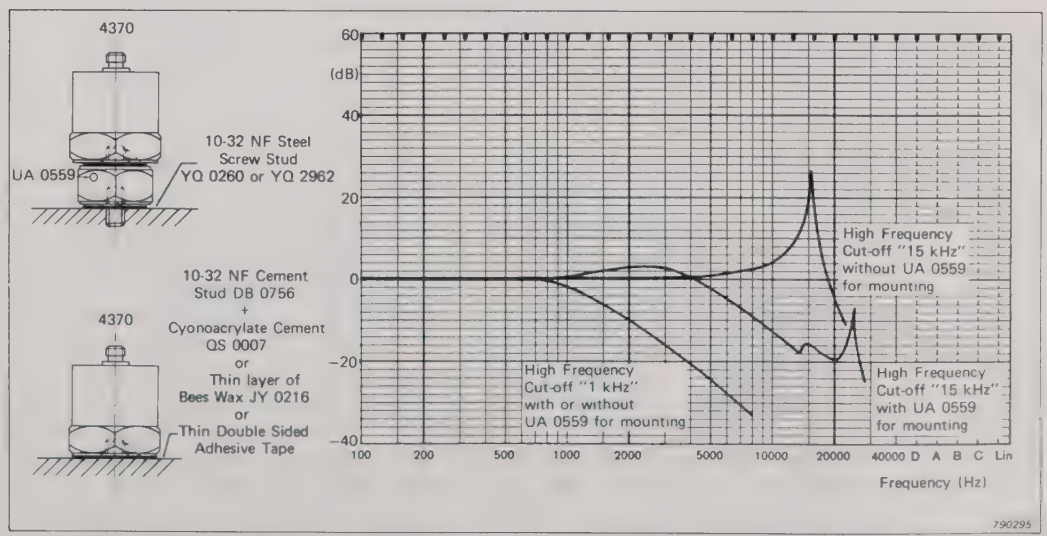


Fig.3.6. Methods of mounting Uni-Gain® Accelerometer Type 4370 and examples of typical frequency responses obtained

helps prevent high frequency vibration components stimulating the 4370 at its resonance frequency.

For further details on this and other types of accelerometer mounting, the B & K "Piezoelectric Accelerometer and Vibration Preamplifier" Handbook should be consulted.

3. Connect the Accelerometer output to one of the INPUT sockets of the 2511, using the 3 or 10 m long low noise accelerometer cable supplied.

   If necessary longer accelerometer cables may be used without influencing the overall sensitivity of the accelerometer and vibration meter. However, for measurement of very low vibration levels cables should be kept short to minimize noise.

4. Using the ACC.-VEL.-DISPL. knob, select the appropriate measurement mode and lower frequency limit for measurements. Generally it is best to select the highest lower limiting frequency consistent with the expected frequency content of the measured vibration. For accurate measurements on shock and transient vibration the use of the "Acc." modes are to be preferred because of their broad band frequency characteristics.

5. Set the HIGH FREQ. CUT OFF switch on the rear panel for a high frequency measurement limit of "1 kHz" or "15 kHz", whichever will exclude or help minimize the influence of the accelerometer mounted resonance frequency. See Fig.3.6.

6. With the left-hand METER FUNCTION switch, select one of the following settings:

   "RMS" for measurement of the root mean square level of continuous periodic vibrations such as developed by rotating machines.

   "Peak-Peak" for measurement of the peak to peak level of continuous or short duration vibrations.

7. With the right-hand METER FUNCTION switch, select one of the following settings:

   "1 s" for measurement of steady or slowly changing vibration levels.

   "10 s" for a steady indication with fluctuating vibration levels.

   "Max. Hold" for measurement of the Max. RMS or Max. Peak to Peak level of short duration vibrations and mechanical shocks.

8. Apply the vibration to be measured and successively step the RANGE I-II knob anticlockwise to obtain a suitable meter indication. With each step wait for the meter pointer to settle before taking readings or stepping the RANGE I-II knob a further position. If the OVERLOAD lamp remains lit for more than a few seconds, step the RANGE I-II knob clockwise until it no longer remains continuously lit. To reset the meter indication when the "10 s" or "Max. Hold" METER FUNCTION switch setting is employed, select the "1 s" setting.

   The vibration level corresponding to full scale pointer deflection on the meter is displayed in the FULL SCALE WINDOW just above the RANGE I-II knob. Remember RANGE I settings give readings in metric units (ms^{-2}, mms^{-1} or mm), whilst RANGE II settings give readings in english unit (g, inch/s or inch).

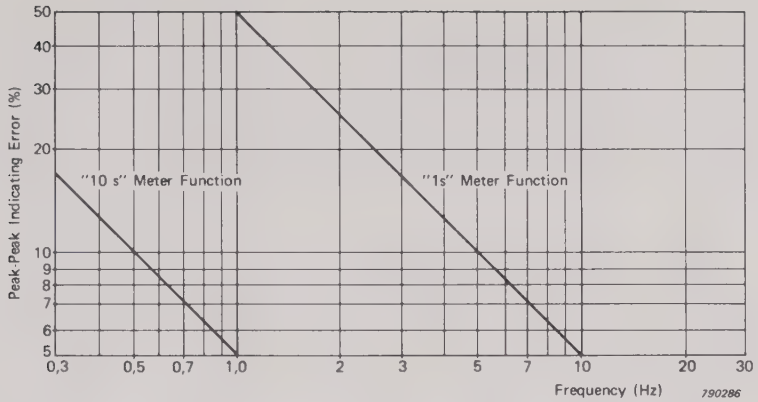


Fig.3.7. Low frequency peak to peak indicating error

Note: When using the "Peak-Peak" METER FUNCTION for measurement on continuous and repetitive transient vibrations, low frequency components of the measured vibration can cause indication errors. As indicated in Fig. 3.7 the amount of error depends on the frequency of the vibration and the meter time constant selected with the METER FUNCTION switch. Comparison of the meter readings obtained with the "1 s" and "10 s" meter time constants will show whether an error is present. If there is a substantial difference in the magnitude of the readings, then measurements should be carried out with the "10 s" time constant selected to keep errors to a minimum.

3.5. USE WITH OTHER PIEZOELECTRIC ACCELEROMETERS

The 2511 may also be used with piezoelectric accelerometers other than the 4370 supplied. Of particular benefit are the B & K Uni-Gain® Accelerometers 4371 and 8306 which as specified in Table 3.1 allow measurement of high and very low vibration levels with the 2511. The use of these accelerometers, as well as non-unigain types having "odd" charge sensitivity values, is discussed in the following sections.

2511 Measurement Mode		Accelerometer 8306 (1000 pC/ms^{-2}) Measurement Level		Accelerometer 4370 (10 pC/ms^{-2}) Measurement Level		Accelerometer 4371 (1 pC/ms^{-2}) Measurement Level	
		Min.	Max.	Min.	Max.	Min.	Max.
Acc. 0,3 Hz	ms^{-2}	0,0001	1	0,002	100	0,02	1000
	g	0,00001	0,1	0,0002	10	0,002	100
Vel. 3 Hz*	mms^{-2}	0,001	10	0,02	1000	0,2	10000
	inch/s	0,00005	1	0,001	100	0,01	10000
Displ. 10 Hz**	mm	0,0001	0,1	0,0003	10	0,003	100
	inch	0,00001	0,01	0,00002	1	0,0002	10

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* If the next lower low-frequency setting is selected for velocity measurements, the minimum limit is a factor of 3 to 4 times higher

** If the next lower low-frequency setting is selected for displacement measurements, the minimum limit is approximately 10 times higher.

Table 3.1. Wide band measurement level limits of 2511 with Uni-Gain® Accelerometers Type 4370, 4371 and 8306. Max. limits are RMS or Peak to Peak values. Min. measurement Limits are RMS values only and are a factor of approximately 2 higher than the noise floor

3.5.1. Low g Uni-Gain® Accelerometer Type 8306

This accelerometer is especially designed for measurement of very low level vibrations on large structures such as building, bridges and ships etc. For a high vibration sensitivity it has its own preamplifier built-in which is furnished with separate 10 V/g (1000 mV/ms $^{-2}$ voltage) and 10 nC/g (1000 pC/ms $^{-2}$ charge) outputs, plus a +28 V (power) input.

Provided that the 2511 is powered via its internal battery supply or via an external +4 to +12 V supply, then the preamplifier of the 8306 may be powered directly from the +28 V (2 mA) OUTPUT socket of the 2511. For connection of the preamplifier power input and charge output to the 2511, two 3 m long, reinforced miniature accelerometer cables are supplied with the 8306. However, should longer cables be used then the voltage output of the 8306 should be connected to the 2511. This has an output impedance of less than 500 Ω and therefore is less susceptible to cable noise. Also unlike other piezoelectric accelerometers, the 8306 may be connected by long connecting cables without influencing its voltage sensitivity.

For connecting the voltage output of the 8306 to the 2511, the INPUT socket on the rear panel of the 2511 should be fitted with the BNC to miniature coaxial socket adaptor WB 0251. This is available on special order and contains a precision 1 nF capacitor necessary for application of voltage signals to the Vibration Meter.

The calibration and measurement procedure for the 8306 is similar to that described in sections 3.3.1 and 3.4. However, owing to the very high charge sensitivity of the accelerometer, the pC/ms $^{-2}$ scale of the meter should be multiplied by a 100 when calibrating the measuring arrangement. Similarly, for measurements the meter scale and the full scale range indication should be divided by a 100 to determine the exact vibration level.

For fixing the 8306 to the measurement point, it is supplied with 10-32NF steel screw studs plus thick double sided adhesive discs. As indicated in Fig.3.8 the best overall vibration response is obtained with stud mounting. This gives a linear frequency response at all frequencies up to 1 kHz, with mounted resonance frequency at about 5 kHz which is heavily attenuated by a low pass filter in the accelerometer. Mounting by means of the thick double sided adhesive discs facilitates quick easy mounting of the accelerometer

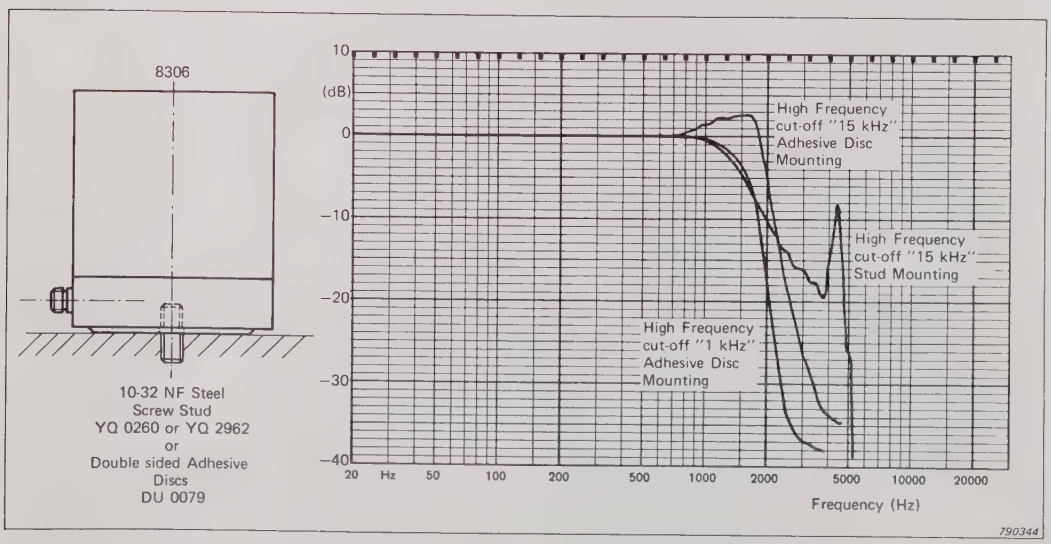

Fig.3.8. Vibration response of Uni-Gain® Accelerometer Type 8306

on concrete and other surfaces, but gives a lower resonance frequency and therefore can only be recommended for non-critical vibration work. If a response approaching that of stud mounting is required, then thin double sided tape or bees' wax should be used.

Note: As the 8306 includes its own low pass filter the HIGH FREQUENCY CUT OFF switch of the 2511 should be set to "15 kHz" for optimum linearity when the accelerometer is stud mounted. When less rigid mounting methods are used, the switch should be set to "1 kHz".

3.5.2. Uni-Gain® Accelerometer Type 4371

Accelerometer Type 4371 has a unified charge sensitivity of 1 pC/ms $^{-2}$, which being a factor of 10 less sensitive than the 4370 may be used for measurement of high level vibrations with the 2511. Provided that it is fixed to the measurement point by means of a 10-32 NF screw or cement stud, or some other rigid mounting method, then it may be used at frequencies up to 15 kHz without its mounted resonance frequency significantly influencing measurements. Calibration of the 4371 together with the 2511 is similar to that described in section 3.3 and 3.4, except that the "Cal.-pC/ms $^{-2}$" scale of the meter should be divided by 10, whilst the measurement scale and full scale range indication should be multiplied by 10 in order to determine the exact vibration level.

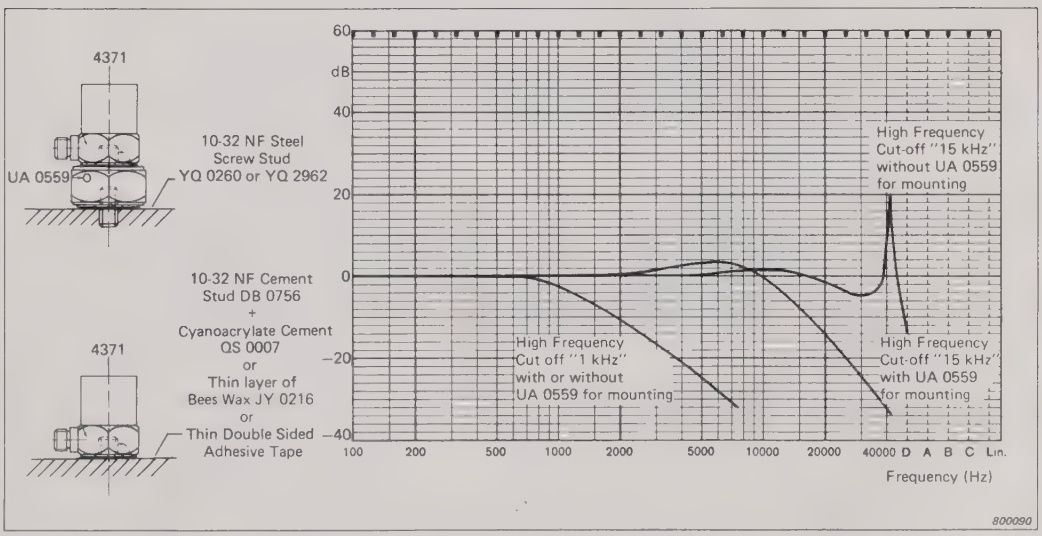

Fig.3.9. Vibration response of Uni-Gain® Accelerometer Type 4371

3.5.3. Non Uni-Gain Accelerometers

The 2511 may also be used with non uni-gain accelerometers. With accelerometers having a charge sensitivity of between 7 and 13 pC/ms $^{-2}$ (or some decade multiple or fraction of these values) calibration and measurements may be performed as in section 3.3 and 3.4 except that the sensitivity and measurement indications provided by the meter must be multiplied by the appropriate correction factors given in Table 3.2.

With accelerometers having a charge sensitivity outside the 7 to 13 pC/ms $^{-2}$ range (or decade multiple or fraction thereof) calibrate the 2511 for a charge sensitivity 10 pC/ms $^{-2}$ as described in section 3.3.1. For measurements multiply the meter indication by:

$$\frac{10}{S_q}$$

where S_q is the exact charge sensitivity of the accelerometer in pC/ms^{-2}.

An alternative method of using the 2511 with the non-unigain accelerometers is to condition the accelerometer sensitivity to a unified value of $10\,mV/ms^{-2}$. This can be done using any B & K Charge Amplifier, details of which can be found in the B & K Short and Main Catalogues. For connection of the 2511 to the output of the Charge Amplifier, the INPUT socket on the rear panel of the 2511 should be fitted with the BNC to miniature coaxial socket adaptor WB 0251. See section 3.5.1.

Accelerometer Charge Sensitivity (pC/ms^{-2})	Multiplication Factor	
	Sensitivity Indication	Measurement Indication
0,07 – 0,13	0,01	100
0,7 – 1,3	0,1	10
7 – 13	1	1
70 – 130	10	0,1
700 – 1300	100	0,01

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Table 3.2. Multiplication factors for operation of the 2511 with non Uni-Gain® accelerometers

3.6. USE WITH EXTERNAL FILTERS

It is often advantageous to use an external filter with the 2511, either for frequency analysis of the vibration signal or for elimination of noise when low frequency displacement measurements are made. For this purpose Tunable Band Pass Filter Type 1621 or Tracking Filter Type 1623, discussed in Chapter 1 may be used. Both have their own internal battery supply and may be connected directly to the TO EXT. FILTER INPUT-OUTPUT sockets on the rear panel of the 2511 as shown in Fig.3.10. For calibration and measurements with the filter connected the EXT. FILTER switch of the 2511 should be set to "In".

Note: If a non B & K filter is connected then it should have an input impedance of at least 100 kΩ and an output DC offset voltage of less than 1,0 mV.

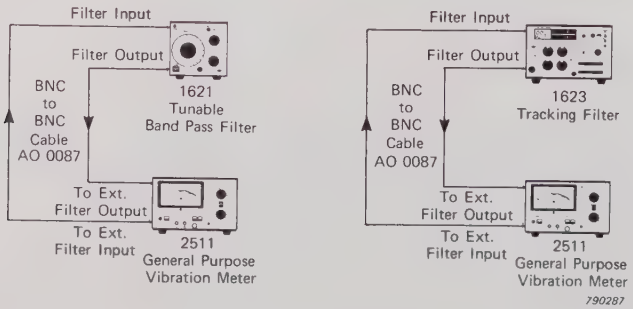

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Fig.3.10. Connection of B & K Band Pass Filters for operation with the 2511. Suitable B & K connection cables are also indicated

3.7. CHANGING METER SCALES

In addition to scale SA 0183 which is supplied installed in the 2511, a linear dB scale SA 0208 is provided. This is graduated from —40 to 0 dB (relative to the value displayed in the FULL SCALE window just above the RANGE I-II knob) and is especially useful when vibration measurements and analyses are plotted using a Level Recorder Type 2306 or 2309 fitted with recording paper having a linear dB scale (see section 4.1). To help convert to vibration units the relationship between the dB and percentage graduations of the two meter scales is shown in Fig.3.12.

To change meter scales, proceed as follows:

1. Set the BATTERY switch to "Off" and if connected, disconnect the external power supply.

2. Using a small screwdriver, remove the two screws fastening the top panel to the rear of the instrument, and slide the panel off.

3. Pull back the spring clip at the top of the meter, insert the tip of the screwdriver in one of the two holes at the top of the scale and lift the scale out. See Fig.3.11.

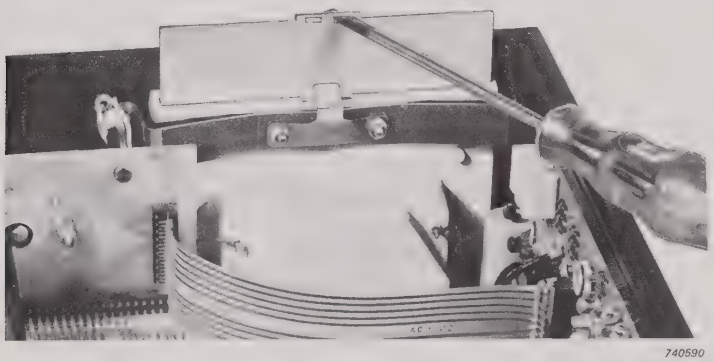


Fig.3.11. Installation of meter scale

4. Insert the new scale and replace the top panel making the 2511 ready for operation.

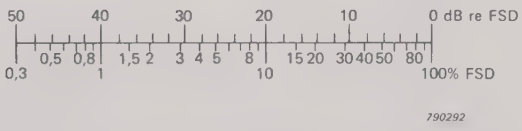


Fig.3.12. Relationship between dB and % scale graduations

4. RECORDING VIBRATION MEASUREMENTS

4.1. LEVEL RECORDING

For an accurate, hard copy, plot of vibration levels as a function of time, the 2511 may be used with one of the B & K Portable Level Recorders Types 2306 or 2309. Depending on the particular output and record mode selected on the Vibration Meter and Level Recorder combination, AC Log as well as DC Lin and DC Log recordings can be made so as to suit different investigation and documentation needs.

With AC Log recording, the AC output signal of the 2511 is rectified and averaged by the rectifier and writing system of the Recorder. This extracts the RMS level of the measured vibration signal which is plotted with a logarithmic amplitude (linear dB) scale utilizing the full dynamic range available with the 25 or 50 dB range potentiometer of the Recorder. These same range potentiometers may also be used for DC recording, however, in this case the meter circuit of the 2511 is used to rectify and average the signal before it is applied to the Recorder. This has the advantage that peak to peak as well as RMS levels may be recorded and that averaging is performed by precise electrical time constants in the 2511. Furthermore, depending on the particular DC Lin or DC Log output mode selected on the 2511, RMS or Peak-to-Peak levels can be plotted with a linear or logarithmic amplitude scale which is required can be compressed or expanded to suit the maximum amplitude excursion of the measured signal. A minor disadvantage is that the bottom 40 to 50 dB of DC Log recordings may not be used for accurate evaluation of vibration levels as the meter circuit of the 2511 is non linear outside its normal 40 dB working range. Also calibration is slightly more involved than that used for AC Log recordings and requires the use of an external vibration level reference source such as the Accelerometer Calibrator Type 4291.

The setting up and calibration procedure for recording from the 2511 is given in the following sections. For simplicity, reference is made to the 2306 Level Recorder only. However, a similar procedure may be used with the 2309 Level Recorder.

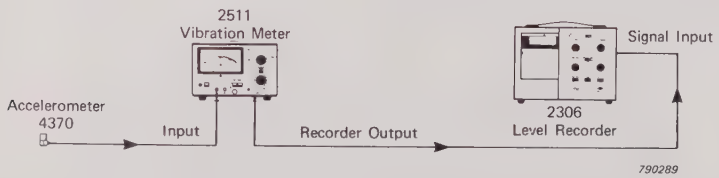


Fig.4.1. Use of 2511 Vibration Meter with 2306 Level Recorder

4.1.1. AC Log Recording

For this type of recording it is recommended that Recording Paper QP 0120 is used with the Level Recorder. This is intended for use with the 50 dB Range Potentiometer of the Recorder and is printed with logarithmic amplitude graduations matching those of meter scale SA 0183 installed in the 2511. If linear amplitude (or dB) graduated paper such as QP 0102, QP 0124 or QP 0143 is employed, then the Recorder may be fitted with a

25 or 50 dB Range Potentiometer. However, in this case the 2811 should be fitted with the dB scale SA 0208, as discussed in section 3.7.

The AC Log recording procedure is as follows:

1. Fit the Level Recorder with the particular Range Potentiometer and Recording Paper required for recording, and set its POWER push-button to "On" (inner position).

2. Turn the SENSITIVITY knob to "0" and set its RECORDING MODE switch to "AC Log".

3. Set the RECORDER OUTPUT switch on the rear panel of the 2511 to its "AC" position and connect the RECORDER OUTPUT socket of the 2511 to the SIGNAL INPUT socket of the Level Recorder.

4. Using the internal reference voltage source or an external vibration reference level, calibrate the 2511 as described in section 3.3. See also section 3.5 if an accelerometer other than the 4370 is employed.

5. Leaving the reference source connected, set the PEN DRIVE push-button of the Recorder to "On", and adjust its SENSITIVITY knob to move the pen to a level graduation on the recording paper, corresponding with the reference level indicated by the meter. See examples given in Fig.4.2 and 4.3.

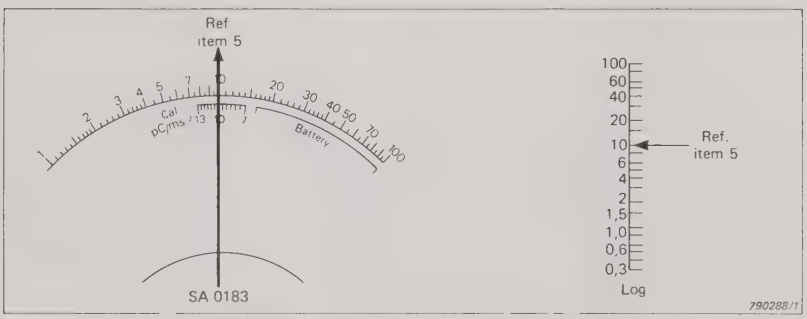


Fig.4.2. Calibration of the Level Recorder pen deflection for AC Log recording when a 50 dB Range Potentiometer and logarithmic amplitude graduated Recording Paper QP 0120 are fitted

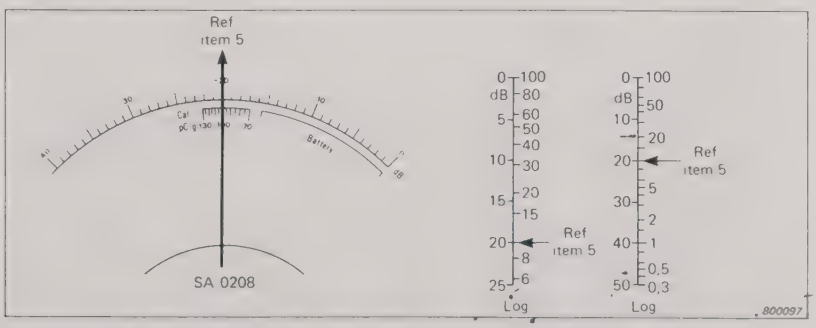


Fig.4.3. Calibration of the Level Recorder pen deflection for AC Log recording when a 25 or 50 dB Range Potentiometer and linear amplitude graduated Recording Paper QP 0102, QP 0124 or QP 0143 are fitted

If linear amplitude graduated recording paper and the dB scale SA 0183 are used, note the exact number of dB the meter pointer is below full scale and set the pen the same number of dB below the thick line at the top of the paper.

6. Disconnect the reference source and keeping the METER FUNCTION switches of the 2511 set to "RMS — "1 s" select the appropriate ACC.-VEL.-DISPL. switch mode for measurements.

7. Apply the vibration to be recorded and adjust the RANGE I-II knob of the 2511, to obtain a suitable pen deflection that does not exceed full scale.

   Provided that the SENSITIVITY knob of the Recorder is not touched, full scale pen deflection will correspond to the value displayed in the FULL-SCALE window on the 2511, whatever particular measurement range is selected.

8. Select a suitable PAPER SPEED and WRITING SPEED setting for recording. With AC recording any WRITING SPEED setting may be chosen, bearing in mind that this influences the effective averaging time and lower frequency limit of the Recorder.

9. Set the Recorder PAPER DRIVE push-button to "On" (inner position) to commence recording. To stop recording set the PAPER DRIVE push-button to "Off" (outer position).

4.1.2. DC Lin and Log Recording

Calibration for these types of recording is easiest to perform with the logarithmic graduated meter scale SA 0183 fitted in the 2511. For DC Log recording the use of Recording Paper QP 0120 having logarithmic amplitude graduations is to be preferred, whilst for DC Lin recording Recording Paper QP 0102, QP 0124 or QP 0143 having linear amplitude graduations may be used. The maximum DC record range available is 40 dB. This is determined by the meter circuit of the 2511 and is not influenced by the particular Range Potentiometer used with the Recorder. However, for maximum record sensitivity the use of the 25 dB Range Potentiometer is to be preferred.

The DC Lin and DC Log recording procedure is as follows:

1. Fit the Level Recorder with a 25 dB Range Potentiometer plus a roll of suitable recording paper.

2. With the POWER push-button set to "On" (inner position) set the RECORDING MODE switch to the Recorder to its "DC Lin" position and turn the SENSITIVITY knob to "0".

3. Leaving the SIGNAL INPUT socket of the Recorder open circuit, set the PEN DRIVE push-button to "On" (inner position) and adjust the DC LIN. POSITION knob to move the pen to the thick line at the bottom of the recording paper. After performing this adjustment, set the POLARITY switch to "+".

4. Set the RECORDER OUTPUT switch on the rear panel of the 2511 to the appropriate "DC Lin" or "DC Log" mode for recording, and connect the RECORDER OUTPUT socket of the 2511 to the SIGNAL INPUT of the Recorder.

5. Using the Accelerometer Calibrator Type 4291, calibrate the 2511 as discussed in Section 3.3.2. See also section 3.5, if an accelerometer other than the 4370 is employed.

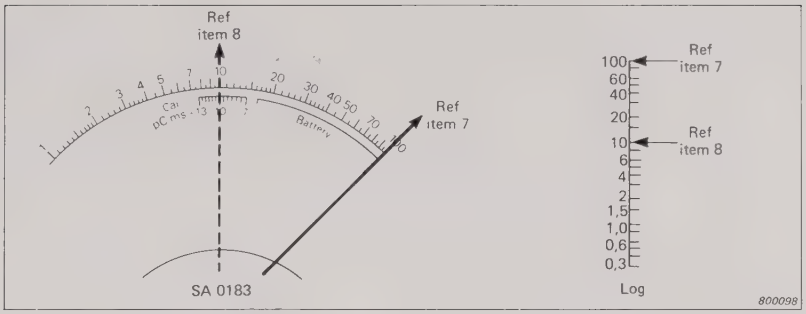


Fig.4.4. Calibration of the Level Recorder pen deflection for DC Log recording, when logarithmic amplitude graduated Recording Paper QP 0120 is fitted. Note, the bottom 0,3 to 1 (10 dB) range of DC Log recording may not be used for accurate evaluation of vibration levels

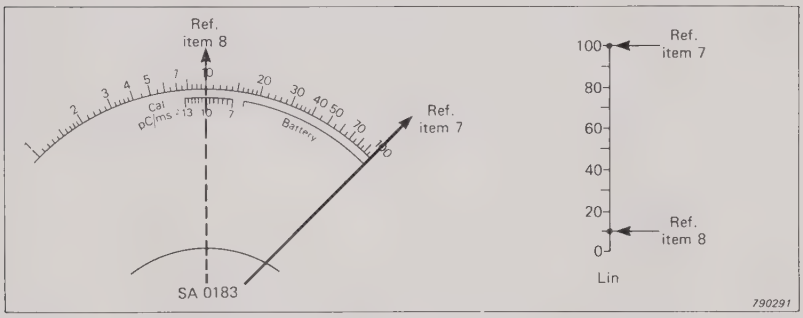


Fig.4.5. Calibration of the Level Recorder pen deflection for DC Lin recording, when linear amplitude graduated Recording Paper QP 0102, QP 0124 or QP 0143 is fitted

6. Leaving the 4291 connected, adjust its ACC. LEVEL knob so that the meter pointer of the 2511 deflects to full scale.

7. With the meter pointer at full scale, adjust the SENSITIVITY knob of the Recorder to move the pen to the thick line at the top of the recording paper. See Fig.4.4 and 4.5.

8. Turn the RANGE I - II knob of the 2511 one step clockwise. As indicated in Fig.4.4 and 4.5 the pen should move a factor of 10 (i.e. 20 dB) below its previous level. If not, adjust the DC LIN. POSITION knob on the Recorder until the correct pen deflection is obtained.

9. Turn the RANGE I-II knob of the 2511 one step anticlockwise and repeat items 7 and 8 once or twice. This will cancel out any interaction in adjusting the DC LIN. POSITION and SENSITIVITY controls, improving the accuracy of the calibration.

10. Disconnect the 4291 and select the appropriate METER FUNCTION and ACC.-VEL.-DISPL. switch modes for measurements.

11. Apply the vibration to be recorded and adjust the RANGE I-II knob to obtain a suitable pen deflection that does not exceed full scale.

Provided that the DC LIN POSITION and SENSITIVITY controls are not touched, full scale pen deflection will correspond to the value displayed in the FULL SCALE window of the 2511, whatever particular measurement range selected.

12. Select a suitable PAPER SPEED knob setting and set the WRITING SPEED knob to "250 mm/s" to prevent the Recorder influencing averaging performed by the 2511.

13. Set the PAPER DRIVE push-button to "On" (inner position) to commence recording. To stop recording, set the PAPER DRIVE push-button to "Off" (outer position).

For further information on level recording, as well as on synchronization of an external filter for semi and fully automatic recording of frequency analyses, the Instruction Manuals for the 2306 and 2309 Level Recorders should be consulted.

4.2. MAGNETIC TAPE RECORDING

Generally it is more convenient, as well as faster to tape record field measurements for later reproduction and analysis in the laboratory. For this purpose the 2511 may be used with the portable FM Tape Recorder Type 7003 shown in Fig.4.6. This is a 2 speed, 4 channel instrumentation tape recorder with overall record-reproduce frequency response extending from DC up to 14 kHz (—3 dB). Compared with audio and direct tape recorders it has a particularly good phase response and therefore in addition to recording of continuous signals may also be used for recording of short duration transient vibrations and mechanical shocks.

For recording of vibration measurements, the EXT. FILTER switch on the rear panel of the 2511 should be set to "Out" and the TO EXT. FILTER socket connected to one of the record channel INPUT sockets of the 7003. With the 2511 calibrated as in section 3.3.1 or 3.3.2 and the INPUT SENSITIVITY potentiometer of the appropriate record channel set to its extreme clockwise position, the nominal output level of the TO EXT. FILTER OUTPUT will correspond to the nominal record and output level of the 7003. Thus provided the RANGE I-II switch of the 2511 is set to its extreme clockwise setting for playback, full scale meter indication will correspond to the particular RANGE I-II setting used for recording the reproduced vibration signal.

Prior to recording measurements, the internal or external reference used for calibrating the 2511 should be recorded on tape. On play back this will allow accurate adjustment of the CAL. potentiometer of the 2511 to compensate the small differences in recorded and reproduced signal amplitudes. For application of the reproduced signal to the 2511, the OUTPUT socket of the appropriate reproduce channel on the 7003 should be fitted with the BNC to miniature socket adaptor WB 0251. This is available on special order and contains a precision 1 nF capacitor necessary for application of voltage signals to the charge input of the 2511.

For further information on the FM Tape Recorder Type 7003, its Instruction Manual or the B & K Short and Main Catalogues should be consulted.

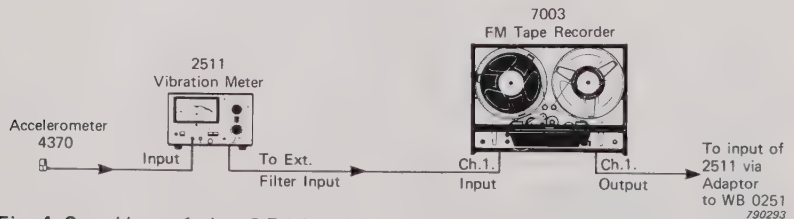
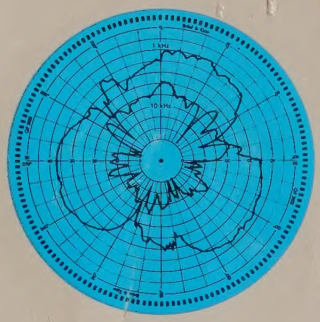
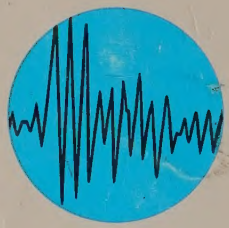


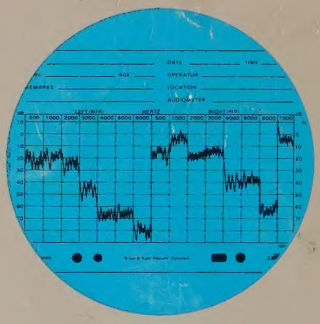
Fig.4.6. *Use of the 2511 with the portable FM Tape Recorder Type 7003*

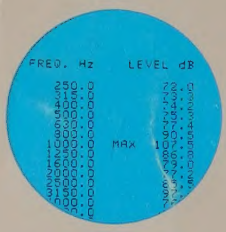
5. SERVICE AND REPAIR

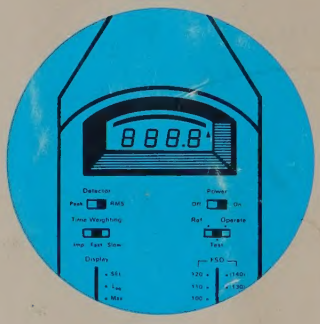
The 2511 is designed and constructed to provide the user with many years of reliable operation. However, should a fault occur which impairs its correct function, then all power should be disconnected to prevent the risk of further damage. For repair consult the separate Service Instruction provided or consult your local B & K service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

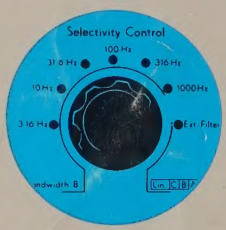


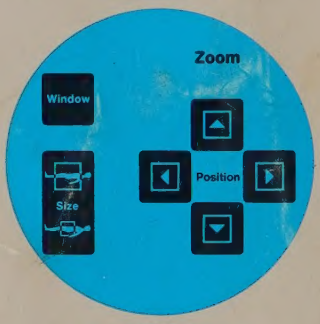


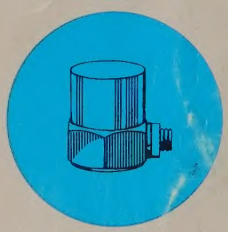


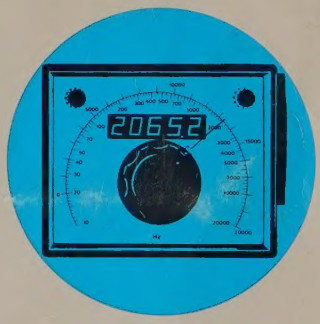


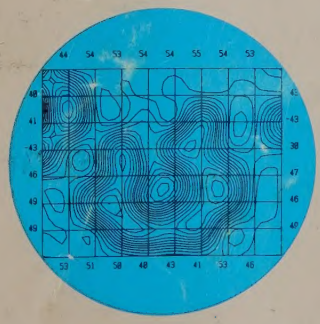


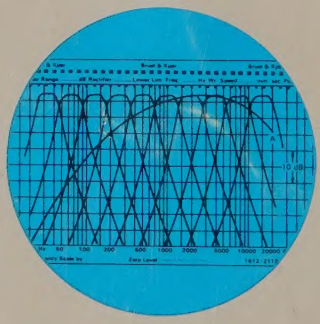












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